
Space Weather Technical Forecast

Issued on Friday, 22 July 2022 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Earth-directed CME expected early tomorrow. G1/Minor Storms expected with G2/Moderate storms likely. Slight chance of M-flares (R1-R2 Radio blackouts) throughout. Chance of Active electron fluence by Day 4 (25 July).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours with numerous C-class flares. The largest of these was from AR3056, which is now over the limb, with a C6.1 flare at 21/2346UTC. There are currently seven sunspot regions on the visible disc. However, none currently display any significant size or magnetic complexity. An earlier C5.7 flare was associated with a filament eruption, which produced a complex CME, with a full halo. This CME has since been analysed as being Earth directed. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, showed the onset of a HSS likely from CH01 and CH02. The wind speed rose gradually from background levels to elevated levels, now varying between 470-550 km/s. Density was initially above average, peaking at 34 ppcc, before dropping around 21/1650 UTC to be average or just above average. The IMF was mainly at moderate levels, but peaked at strong levels between 21/1440-2100 UTC. The north-south component (Bz) varied strongly between +19/-17 nT, but settled to vary mostly weakly after 21/2200 UTC. The phi angle was negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled, with G1/Minor storm (Kp 5) intervals between 21/1500-2100 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at background levels. High energy electron flux was briefly breached the High threshold, peaking at 1230 pfu at 21/ 1730 UTC, but has otherwise been at background to moderate levels. The corresponding 24-hour integrated electron fluence remained below the Active threshold, with a declining trend. Fluence reached 3.54e7 integrated pfu at 22/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Despite a large number of active regions, activity is expected to remain predominantly Low, with a slight chance of isolated M-flares through the period.

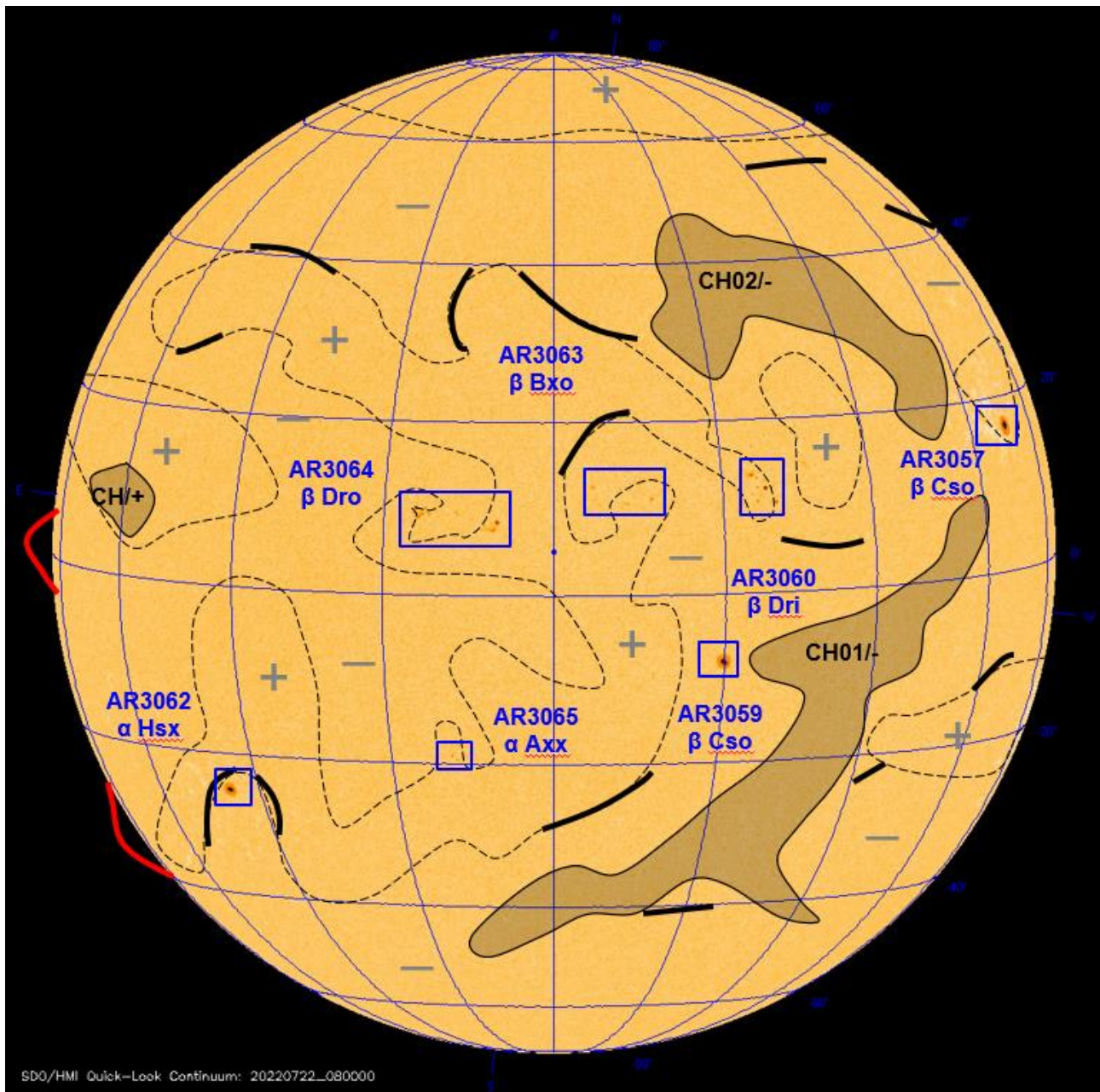
Solar Wind / Geomagnetic Activity: Initially a high speed stream (HSS) environment is expected with elevated wind speeds. Then either late today, or more likely early tomorrow, a CME is expected to arrive with strong wind speeds likely. Combined CME and HSS effects are expected to last through Day 2 into Day 3 (23-24 July) before slowly declining into Day 4 (25 July). Geomagnetic activity is expected to be Unsettled to Active (Kp 3-4) for much of today, due to the HSS effects, with a chance of isolated G1/Minor Storm (Kp 5) intervals at first. With the CME arrival overnight, G1/Minor Storms (Kp 5) are expected to develop, with G2/Moderate (Kp 6) storm intervals likely. There is also a slight chance of G3/Strong (Kp 7) storms occurring. During Days 3 and 4 a gradual decline in activity is expected, reaching Quiet to Unsettled (Kp 2-

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

3) conditions by late Day 4.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is most likely to remain at background levels. The high energy electron flux (greater than 2 MeV) is expected to be at background to moderate levels today and tomorrow (22-23 July) then increase perhaps to High levels at the diurnal peaks on Days 3 and 4 (24-25 July) as CME effects wane. The associated fluence is expected to rise, with a chance of reaching Active on Day 4.

Figure 1. Solar Analysis Valid 22/0800 UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-γ-δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Initially a high speed stream (HSS) environment is expected with elevated wind speeds, from a combination of coronal hole influence from CH01/- and CH02/-. Then either late today, or more likely early tomorrow, an Earth-directed CME is expected to arrive with strong wind speeds likely. This was emitted following a filament eruption near AR3060, near centre disc, early on the 21st. There is moderate to high confidence that the CME will be Earth-directed, but slightly lower confidence for the arrival time, with some ensemble forecast model members showing potential arrival later today, and also later tomorrow morning. Combined CME and HSS effects are expected to last through Day 2 into Day 3 (23-24 July) before slowly declining into Day 4 (25 July).

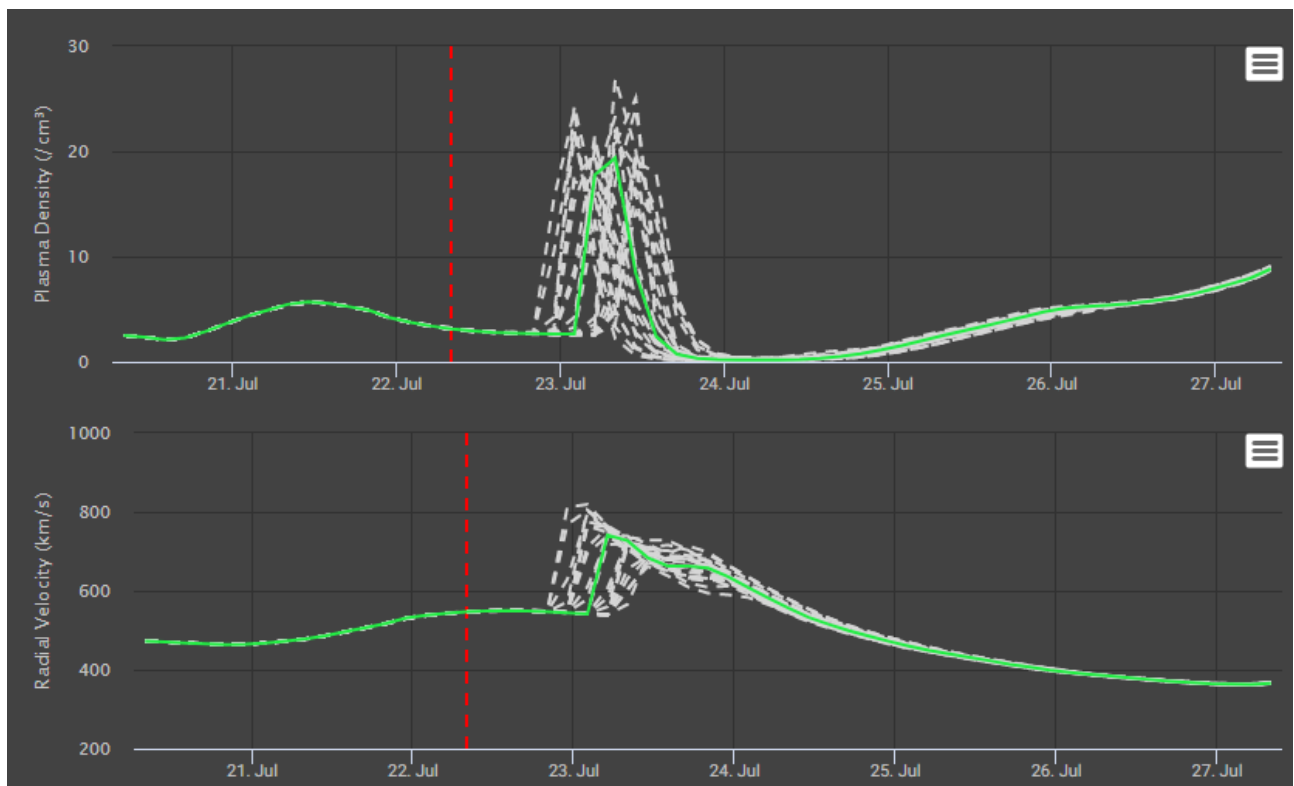
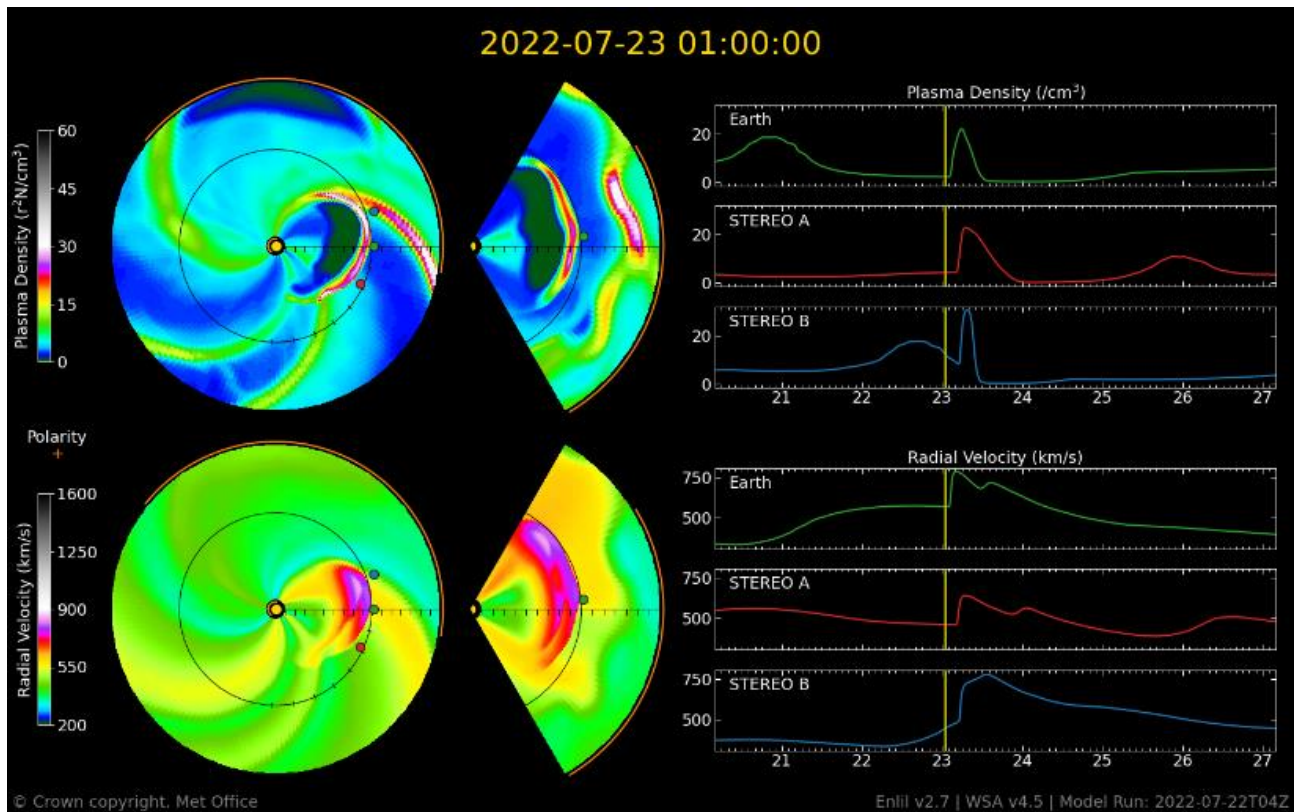
Geomagnetic activity is expected to be Unsettled to Active (Kp 3-4) for much of today, due to the HSS effects, with a chance of isolated G1/Minor Storm (Kp 5) intervals at first. With the CME arrival overnight, G1/Minor Storms (Kp 5) are expected to develop, with G2/Moderate (Kp 6) storm intervals likely. There is also a slight chance of G3/Strong (Kp 7) storms occurring. During Days 3 and 4 a gradual decline in activity is expected, reaching Quiet to Unsettled (Kp 2-3) conditions by late Day 4.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	40	80	20	5
Strong	G3	No	2	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/0409	Full	Filament near AR3060	North centre disc	917	23/0300 UTC	Minor – moderate storms likely

Figure 2: Enlil model and ensemble showing CME arrival, most likely early on 23 July.



Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the last 24 hours. There are currently seven sunspot regions on the visible disc. However, none are particularly large or currently display any significant magnetic complexity. There was little change in most regions in the last 24 hours, although AR3060 showed some minor growth. Through the period a new region may rotate onto the visible disc from the far side.

Despite the large number of active regions, with none being particularly complex, activity is expected to remain largely Low with an ongoing slight chance of isolated M-flares through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. Given that most regions are small and relatively magnetically simple, the risk of a proton enhancement is very low and just slightly above background.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	2	2	2
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux (greater than 2 MeV) is currently at background to moderate levels. It may rise initially under the influence of HSS effects, but an anticipated CME arrival tonight is expected to suppress electron flux levels temporarily. Once the CME effects have started to wane, and increase in flux levels is likely, perhaps reaching High (1000 pfu) at the diurnal peaks on Days 3 and 4 (24-25 July).

The associated fluence is expected to stay below the Active ($1\text{e}8$ integrated pfu) threshold on Days 1 and 2 (22-23 July), but a rise is likely on Days 3 and 4 as CME effects wane. REFM's forecast trend is reasonable, but it won't be taking account of CME effects and as such isn't likely to give good guidance in the upcoming day or two.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	5	5	20	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 3: Fluence currently on a declining trend. REFM will not take into account CME effects.

